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VOL. XI LANCASTER, PA., APRIL, 1921 NO. 8

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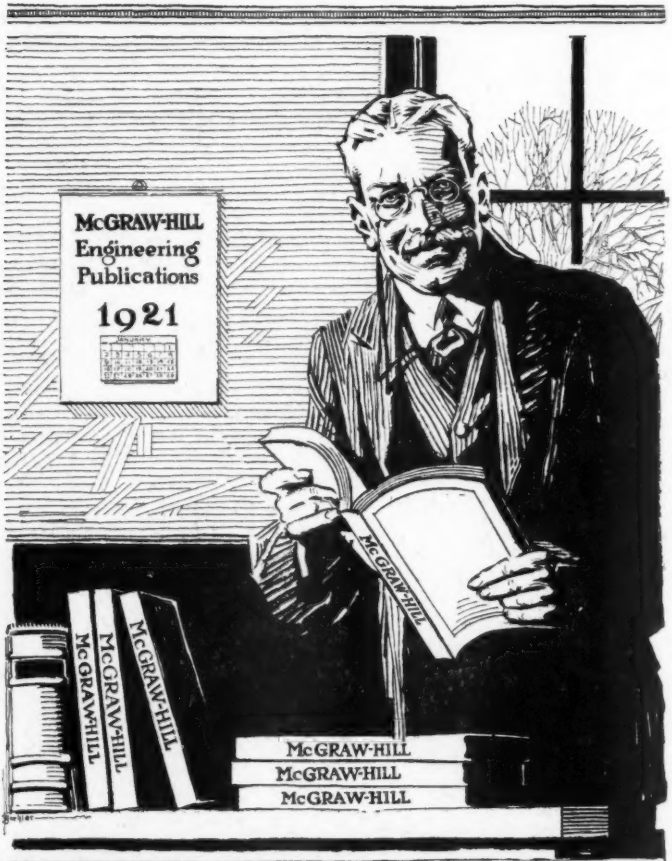

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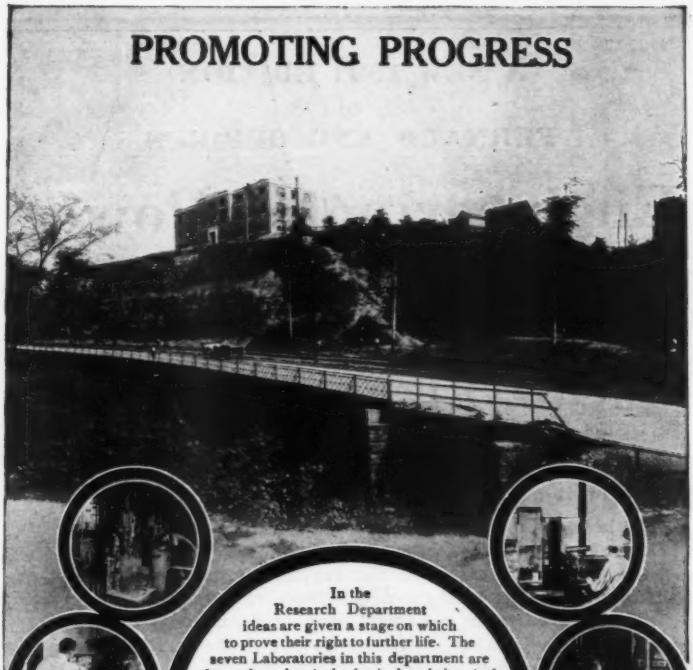

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BULLETIN

OF THE

Society for the Promotion of Engineering Education

Published under the supervision of the Publication Committee:

Arthur M. Greene, Jr., Mortimer E. Cooley, F. L. Bishop, *Editor.*

Address all communications to the Editor, University of Pittsburgh, Pittsburgh, Pa.

VOL. XI LANCASTER, PA., APRIL, 1921 NO. 8

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YALE COLLEGE. View Past Connecticut Hall, on Old College Campus.

YALE UNIVERSITY.

BY MINOTT A. OSBORN,

Assistant Secretary of the University.

What follows is intended to convey to the mind of the prospective Yale visitor representative impressions of the city of New Haven and something of the history, growth, and aims of Yale University. The union of Town and Gown is over two centuries old. Hence it is in a large measure true that the University is best understood in its relation to its historical environment, while the city derives its character and its standing to a considerable extent from the institution of learning which since 1716 has exerted a steadily increasing influence upon it.

New Haven Nearly Three Centuries Old.

Settled in 1637 by a band of English Puritans, New Haven antedated by nearly seventy-five years the founding at Saybrook, in 1701, of the Collegiate School of Connecticut, later to be removed to New Haven and to be given the name of its first great benefactor, Elihu Yale. New Haven, or Quinnipiac as it was originally known, was at the very start planned with care. As a result, a great deal of the city's charm to-day is derived from the central "Green" which the settlers laid out in the form of a large square. Three churches, each one a century old, in the center of the Green facing the east have replaced the first structures, while residences and public buildings border the enclosure in accordance with the early arrangement. To the west and north lie the Yale College campus and other buildings of the University.

To-day not only Yale but a large variety of manufacturing interests and other commercial activities cause New Haven

to be widely and favorably known. With a population well over one hundred and fifty thousand, so situated as to be accessible readily by rail, water, and trolley routes to New York, Boston, and other large Eastern cities, New Haven possesses a good deal of the atmosphere of a large city, at the same time retaining some of the rightly esteemed characteristics of a smaller New England community. Not the least of the advantages which New Haven derives from its natural endowments and its historical associations are the attractions which it offers to the home seeker or the Yale student. For notwithstanding the fact that it not only has developed great manufactories like Winchester's, but is the largest city in point of population in the state of Connecticut, New Haven is essentially a city of homes. In such a community Yale University has its permanent home.

Strangers find New Haven a delightful city to visit. Located on Long Island Sound, whose Connecticut shore-front presents a variety of pleasing scenery, the city enjoys distinctive advantages. Other attractions close at hand are the country clubs with their golf courses and numerous rural stretches that beckon the motorist and the tramper alike. Few cities offer such opportunities for excursions into a charming country-side. Conspicuous within the city limits are the residential districts with their green-bordered streets and their trim gardens. Finally, there is the restfulness of numerous city parks. Whether for the individual visitor or for members of a convention, New Haven possesses many attractions not ordinarily found in combination.

Yale's Beginnings.

One fact regarding the foundation of the modern Yale University is of special interest because it is as much a factor and a leading purpose in Yale to-day as it was in 1701 when a small group of Connecticut ministers chartered a Collegiate School to fit the youth of the land for public service "in Church and Civil State." Yale University in 1921 is

definitely equipped to train its students for public service in various useful walks of life. Another fact of special interest is that the original Yale was literally a collection of books, while to-day the heart of Yale University is a library of a million and a quarter books for which the most adequate and beautiful building which a munificent bequest can make possible is about to be provided. Many are the links that bind the Yale of the twentieth century to the humble collegiate school of the eighteenth.

John Hart, of the class of 1703, was the first recipient of a Yale B.A. Later the martyr Nathan Hale of the class of 1773 and a long line of men of distinction in the professions, in education, in statesmanship, in the field of invention, and in every walk where trained intellects and character make for leadership were added to Yale's growing list of eminent men.

Of the evolution of Yale University with its two undergraduate schools, its graduate school, and its six professional schools shaping their courses to meet modern educational needs, this is not the place to speak in detail. But it may be remarked that when in 1887 the general assembly of the state adopted an act authorizing the name Yale University the institution had come to be in fact a university rather than a mere school or college. To-day Yale's great aim and opportunity is to coördinate the work of its schools and to place such emphasis upon productive scholarship as well as inspired teaching that it will be a modern university in the best sense of the term. Finally, the presence of students from every part of the nation is making Yale a representative national and international university rather than the sectional institution which in its earlier stages it was bound to be. To this end the reorganized Board of Admissions has recently made the important announcement that the "New Plan" of entrance examinations has been so altered that any boy who has done creditable work in any secondary school of the country may hope to gain admission directly from his school by passing four examinations based on the work of his senior

year in that school. This means no lowering of the Yale scholastic bars but a widening of the gate by which the student enters and promises to make Yale more truly than in the past a national institution knowing no limits, territorial or otherwise.

Growth of a Decade.

Several outstanding changes in the past ten years are worthy of mention. Most obvious are the financial development and the material growth of Yale. In ten years the university's endowment has increased from approximately twelve millions to more than double that amount. This figure, moreover, does not include the bequest of the late John W. Sterling, a graduate of Yale College, who left his large fortune to Yale upon his death a few years ago. This legacy, amounting to about twenty million dollars, is to be used for memorial buildings, scholarships, fellowships, lectureships, the endowment of new professorships, and the establishment of special funds for prizes. It will add on the one hand to the institution's physical plant and architectural beauty and on the other to Yale's opportunity of educational expansion. Notable among the buildings recently added to the University's equipment may be mentioned several University laboratories, two laboratories of engineering in the Sheffield Scientific School, Sprague Memorial Hall (the School of Music), Artillery Hall and Artillery Armory for Yale's field artillery R. O. T. C. unit, the Brady Memorial Laboratory for pathology in the Medical School, and what is in many ways the greatest addition to the University's property holdings, the Memorial Quadrangle of six courtyards, the gift of Mrs. Stephen V. Harkness of New York City and the work of James Gamble Rogers of New York City, architect. The last-named group, erected at a cost of several million dollars, is described by competent critics as one of the finest examples of Gothic architecture in the world and as the most beautiful group of college buildings in America.

CAMPUS OF THE SHEFFIELD SCIENTIFIC SCHOOL, YALE UNIVERSITY, showing Vanderbilt Dormitories.

Conspicuous Literary Achievements.

In no one single field has Yale's advance in a decade been more impressive than in the general field of literature and publishing. On the campus, where the *Yale Literary Magazine*, founded in 1836, enjoys the distinction of being the oldest American college magazine in point of continuous publication, the Elizabethan Club, with its notable collection of Shakespeare folios and quartos and early editions of other Elizabethan dramatists, has come to be since its establishment in 1911 a center of student literary interest. One of the patent results of this quickening of literary interest has been the extraordinary line of younger Yale poets in recent years.

Most far-reaching is the scope and influence of the Yale University Press, founded in 1908 under an agreement that all books bearing the Yale Press imprint and the name of Yale should first receive approval by the University Council's Committee on Publications. The Press is affiliated with the Oxford University Press and through the publication of such works of scholarly and in the best sense popular interest as the Yale Shakespeare and the "Chronicles of America" lays successful claim to being one of the most important publishing agencies in this country.

Not less favorably known is *The Yale Review*, which was transformed into a quarterly review in 1911 and placed under the able editorship of Wilbur L. Cross, dean of the Yale Graduate School. Although published under Yale auspices, the *Review* has taken its place as a leading national publication, as the large non-Yale portion of its rapidly growing list of subscribers proves.

New Educational Organization.

Following the war period, during which over 8,000 Yale men were in the armed forces and the University became practically a Government training post and laboratory, an inventory was made of the University's organization. The result was a series of changes adopted in March of 1919 that were

MEMORIAL QUADRANGLE, YALE COLLEGE, showing Wrexham Tower. Said to be Finest Group of College Buildings in America. Copyright by Bachrach, Inc.

in many instances of a radical nature. New University offices created included a provost to assist the president in educational matters, a dean of students to oversee student morale, and a dean of freshmen, who with a separate faculty was placed in charge of a single undergraduate freshman year to serve for both Yale College and the Sheffield Scientific School and to offer the best teaching and the best individual oversight for members of the first-year class. At the same time all graduate work was centered in the Graduate School. The admission of all students was centralized in a board of admissions under a chairman named by the Yale corporation. Departmentalization of the faculty according to subjects taught brought about several desirable results and provided a new basis for representation on the reorganized University Council, which become the central educational policy-determining body of the University. Other so-called reorganization measures resulted in the extension of the Sheffield Scientific School course from three to four years, the elimination of the "Select Course" and the transfer of the degree of Bachelor of Philosophy to the College; the allying of the Medical School with the New Haven Hospital and the placing of the Medical School faculty on the full-time basis; similar expansion for the law school, and the increasing of faculty salaries. Last and in many respects among the most important of the features of the reorganized Yale, a strong department of education is being built up in the Graduate School under a man who was called from a conspicuous post to develop this department at Yale.

The Campus.

The limits of such a statement as this prevent the description in any detail of campus interests and activities either within or without the curriculum. It may be remarked that few groups of young men address themselves as seriously to extra-curriculum competition as the Yale student body. Everybody takes part in some such activity, whether it be athletic, literary, musical, social, or intellectual. Such or-

ganizations as the various student periodicals, the musical and dramatic clubs, and the many athletic teams give every student his opportunity to exercise such talents as he may possess. Particularly in athletics the ideal in view is general participation with the development of the picked 'varsity team only as an incentive and the possible ultimate attainment. Representative student councils consider problems touching campus life and with the *Yale Daily News*, a powerful moulder of student opinion, lead and crystallize campus thought. Indirectly allied with the influence of the student councils is the functioning of the honor system, which has long been in effect in the Scientific School and which is a feature of the freshman year, instituted last fall as a class common to both Yale College and the Sheffield Scientific School and having its separate dean and faculty. Students take into their own hands cases of violation of the accepted code of honor touching examinations and tests and hand their judgments to the college authorities. Tradition plays a strong part in the Yale student world and no tradition is more authentic than that requiring every man to busy himself with interests that will make him a better campus citizen than he would otherwise be.

A word might be added in view of the belief sometimes given expression in the past that Yale has been a rich man's college. A complete refutation of such a statement can be found in the fact that last year out of a total enrollment of somewhat over 3,000 students 948 were definitely known to be working their way through college in whole or in part, through the assistance in the form of scholarships and self-help opportunities made possible by the University's bureau of appointments, their total of earnings being $262,702.45. Most significant is the fact that many of the leading citizens of the campus world, among them the captain of next year's football eleven and a number of socially prominent men, are self-supporting students. The University is glad to be able to state that no boy need forego a Yale education because of financial limitations.

No attempt has been made in this statement to stress one of the most significant of the recent movements at Yale University—the broadening of Yale's program of instruction in engineering. This is one of the evidences of the fact that the University is on the threshold of even greater expansion than it has experienced in the past. I hope that a subsequent paper from a member of our engineering faculty may do justice to a phase of Yale's present-day growth that is at once interesting and of large importance.

SCHOLARSHIP AND EMINENCE IN ENGINEERING.

BY RAYMOND WALTERS,

Registrar and Assistant Professor of English, Lehigh University.

In the fields of arts college, law school and military school training there have been inquiries into the correspondence between the scholastic standing of students and their success in later life. Aside from one investigation as to Lehigh alumni, there has hitherto been no similar published study in the field of engineering education.

Under the auspices of the American Association of Collegiate Registrars a study was begun in 1919 of the scholastic training of a group of eminent engineers, the results of which are here presented. The findings may moderately be termed important. They show a close correspondence between good scholarship in collegiate courses and professional eminence in engineering.

It should be said at the outset that this study on a nation-wide scale was made possible by the coöperation of registrars of 75 technical schools, colleges and universities, practically all of them members of the Registrars Association. Among other gentlemen who gave helpful suggestions in various ways were Dr. E. L. Thorndike of Columbia University, Dr. C. H. Judd of the University of Chicago, Dr. N. M. Emery, Prof. W. C. Thayer, Prof. Percy Hughes and Prof. L. R. Drown of Lehigh University, Mr. H. W. Craver, Director of the Engineering Societies Library, and Mr. E. G. Grace, President of the Bethlehem Steel Corporation.

The approach in the present study differs from that of most of the investigations in other fields. Those investigations dealt with students who stood high in college and professional school and ascertained their degree of success in

later life. The present investigation deals with engineers who stand high in the engineering world and ascertains their degree of success in earlier scholastic life.

The total number of eminent engineers considered was 730. Of these, 580 were collegiate graduates. The senior class standings of 392 of these graduates were determined and compiled.

Basis of Eminence Rating.

In deciding upon a list of eminent engineers the arbitrary criterion was adopted of (*a*) the holding of office or (*b*) membership in standing committees or (*c*) service as representatives of the four "founder" engineering societies during the five years, 1915–1919 inclusive:

The American Society of Civil Engineers (A. S. C. E.),
The American Society of Mechanical Engineers (A. S. M. E.),
The American Institute of Electrical Engineers (A. I. E. E.),
The American Institute of Mining and Metallurgical Engineers (A. I. M. E.).

These societies during the years covered by this study had an annual total of about 40,000 members. Their requirements for membership call for a high professional standard of ability and character. Their officers and committees and representatives have in general been chosen because of outstanding worth.

This basis was finally adopted as a workable solution of the complex problems of evaluating engineering success. It simplified the point of view by constituting professional eminence an arbitrary standard of engineering success. It met the difficulty of judgment as to professional eminence by listing the men chosen as leaders and representatives by their own professions. The fact that the choice was regular society procedure for five years seems to make it a more normal judgment than special balloting on the subject in any one year—even if balloting could be arranged. And it is probably judgment less vulnerable to challenge than selections that could be made by any individual or committee.

The basis has shortcomings. It leaves out success in other fields. It ignores success which is independent of professional activity and recognition. It tends somewhat to emphasize scientific and ethical aspects.

However, reasonable limitation is a gain. Highly successful engineers outside the societies are likely to be remiss in the obligation which Roosevelt once declared every man owes to the upbuilding of his profession. The scientific and ethical aspects are those which most profit the nation.

To sum up, while it does not include *all* of the eminent engineers in the United States this is undeniably *a* list of eminent engineers; and it is a list sufficiently large to furnish a significant ground for generalization.

Definition of Terms.

The term *eminent* for the purpose of this study means the holding of office or standing committee membership or service as representative in the founder engineering societies during 1915–1919 inclusive; no distinction as to grade of eminence; names repeated counted only once.

The term *collegiate graduates* means graduates of engineering schools and institutions of higher learning in all courses.

The term *non-graduates* means men who attended engineering schools and institutions of higher learning for at least one year but who were not graduated.

The term *secondary school men* means engineers who had in most cases a high-school education or its equivalent in private schools; in some cases considerably less. Precise data could not be obtained to classify these men as to exact length of scholastic training.

The term *scholarship records* means the scholastic standing of graduates for their senior year in college.

Scholastic standing is based upon rank in the

Highest 20 per cent. of the class.
Second 20 per cent. of the class.
Third 20 per cent. of the class.

Fourth 20 per cent. of the class.
Lowest 20 per cent. of the class.

Basis of Class Rating.

The fact of graduation itself establishes a fair degree of scholastic ability. To record higher degrees of scholarship it seemed logical to ascertain the standing of the eminent engineers at the end of their senior year. The main difficulty was the determination of what percentage distribution of the graduating class to ask for. For any class other than the senior class the grouping might be ascertained according to a normal frequency curve; percentile groupings such as 10–25–30–25–10 or 3.5–24–45–24–3.5. But for a selected group like engineering school seniors there seems, in the words of Dr. E. L. Thorndike, to be no "scientific justification for any decision about the distribution."

Accordingly fifths were adopted as a convenient arbitrary rating, and scholastic standing for the senior year was ascertained and reported upon this basis.

Analysis as to Scholastic Training.

Examination of the biographical data in the offices of the four founder engineering societies in New York disclosed that of 730 on the eminent list,

A total of 580 or 79.5 per cent. were graduates of engineering schools, colleges and universities.

A total of 35 or 4.8 per cent. were collegiate non-graduates.

A total of 115 or 15.8 per cent. had secondary-school training only.

The results by societies are shown in Table I.

"Who's Who" and the Eminent List.

In view of its reputation as an honest and intelligent register of renown, "Who's Who in America" was examined in connection with the eminent list upon which this study is based. It was found that, of the 730 names in the professionally eminent list, 315 were included in the nationally

TABLE I.

COMPARISON OF SCHOLASTIC TRAINING OF 730 EMINENT ENGINEERS.

Training.	Society.	Number.	Per Cent.
Collegiate graduate	A. S. C. E.	132	75.9
	A. S. M. E.	168	77.0
	A. I. E. E.	157	84.9
	A. I. M. E.	123	81.4
	All four	580	79.5
Collegiate non-graduate	A. S. C. E.	9	5.2
	A. S. M. E.	6	2.6
	A. I. E. E.	8	4.3
	A. I. M. E.	12	7.9
	All four	35	4.8
Secondary school	A. S. C. E.	35	18.9
	A. S. M. E.	44	20.9
	A. I. E. E.	20	10.8
	A. I. M. E.	16	10.6
	All four.	115	15.8

eminent list of "Who's Who" (Volume X, 1918–19) and these were studied. The task of finding and working up statistics on other engineers in "Who's Who" was not attempted.

Of the 315 engineers included in both "Who's Who" and the Registrars' eminent list, 269 or 85.4 were collegiate graduates; 18 or 5.7 per cent. were collegiate non-graduates; 28 or 8.8 per cent. had secondary-school training only.

Considering the results by engineering societies the figures are:

Of 76 A. S. C. E. representatives in "Who's Who," 67 or 88.2 per cent. were collegiate graduates; 3 or 3.9 per cent. were collegiate non-graduates; 6 or 7.9 per cent. had secondary-school education only.

Of 80 A. S. M. E. representatives in "Who's Who," 66 or 82.5 per cent. were collegiate graduates; 4 or 5.0 per cent. were collegiate non-graduates; 10 or 12.5 per cent. had secondary-school education only.

Of 81 A. I. E. E. representatives in "Who's Who," 71 or

87.6 per cent. were collegiate graduates; 4 or 4.9 per cent. were collegiate non-graduates; 6 or 7.5 per cent. had secondary-school training only.

Of 78 A. I. M. E. representatives in "Who's Who," 65 or 83.3 per cent. were collegiate graduates; 7 or 8.9 per cent. were college non-graduates; 6 or 7.7 per cent. had secondary-school training only.

It will be observed that the percentages of collegiate graduates and collegiate non-graduates run higher for the 315 engineers who were in both "Who's Who" and the Registrars' eminent list than for the 730 engineers on the Registrars' eminent list.

Comment on Scholastic Training.

Statistics have not been compiled as to the percentages of collegiate graduates, collegiate non-graduates and secondary-school men among the forty-odd thousand members of the four founder engineering societies. Estimates by the societies' secretaries as to collegiate graduates range from 50 per cent. to 80 per cent., with a far lower estimated percentage among members fifty years of age or older. Most of the men on the Registrars' eminent list are well over fifty years. They were accordingly graduated in the late '70's, the '80's and the early '90's, when attendance at colleges and particularly at technical schools was small in this country. Youths with engineering ambitions then customarily began their careers in surveying corps and machine shops and railroad offices.

In view of these facts, the figures of this study are significant for the high percentage of collegiate graduates. It is an argument for collegiate institutions as selective and preparatory agencies that, in the group considered, practically 80 per cent. of the 730 eminent names are followed by collegiate degrees.

The low percentage of collegiate non-graduates is noteworthy. At ten institutions furnishing the largest number of names on the Registrars' list slightly more than half of those who entered these institutions up to 1916 were graduated.

Upon the estimate therefore that the relation between the number of those graduating in the collegiate classes investigated and the number of those leaving college for any reason are as six to four, *the chances of engineering eminence would appear to be about eleven times as great for the collegiate graduate as for the non-graduate.*

The product of secondary-school and practical training at its best is exemplified in the 115 representatives on the Registrars' eminent list. There are three times as many of them as of men who started but did not complete collegiate courses.

Analysis as to Class Rating of Graduates.

Of the 580 collegiate graduates on the Registrars' eminent list accurate class ratings were determined for 392, or more than two thirds. Reports can not be given on the others for various reasons. Twenty-seven on the eminent list were graduated at universities and technical schools in Europe, and their records were not asked for. A number of American colleges did not keep records for the years in question. Some records were reported lost by fire or accident. Some records were not accurate and could not be used.

Seventy-five collegiate institutions of the United States and Canada are represented in the total of 392 accurate records reported. The complete list in alphabetical order follows: Allegheny College, Amherst College, Bowdoin College, Brooklyn Polytechnic Institute, Brown University, Case School of Applied Science, Clemson College, Colgate University, College of the City of New York, Colorado College, Colorado School of Mines, Cooper Union, Cornell College (Iowa), Cornell University, Dartmouth College, Delaware State College, Dickinson College, Drake University, Drexel Institute, Franklin College, George Washington University, Hamilton College, Harvard University, Hillsdale College, Johns Hopkins University, Lane University, Lawrence University, Lehigh University, Leland Stanford Junior University, McGill University, Marietta College, Massachusetts Institute of Technology,

Miami University, Michigan College of Mines, Middlebury College, Missouri School of Mines, Montana Agricultural College, New York University, Northwestern University, Oberlin College, Pennsylvania State College, Princeton University, Rose Polytechnic Institute, Rutgers College, State University of Iowa, Swarthmore College, Throop Polytechnic Institute, Tufts College, Union College, University of Arkansas, University of California, University of Chicago, University of Illinois, University of Kansas, University of Maine, University of Minnesota, University of Missouri, University of Nebraska, University of Pennsylvania, University of Rochester, University of Tennessee, University of Texas, University of Toronto, University of Vermont, University of West Virginia, University of Wisconsin, United States Military Academy, United States Naval Academy, Virginia Military Institute, Virginia Polytechnic Institute, Washington University, Wesleyan University, Williams College, Worcester Polytechnic Institute, Yale University.

Results in Detail.

The reports by the registrars of the foregoing institutions upon the class standing at graduation of eminent engineers whose collegiate records were available resulted as follows:

Of 392 men on the Registrars' Association eminent list, representing all four founder societies,

182 or 46.4 per cent. stood in the highest fifth of their classes scholastically;

109 or 27.8 per cent. stood in the second highest fifth of their classes scholastically;

72 or 18.3 per cent. stood in the middle fifth of their classes scholastically;

14 or 3.6 per cent. stood in the next to lowest fifth of their classes scholastically;

15 or 3.8 per cent. stood in the lowest fifth of their classes scholastically.

The results by engineering societies are shown in Table II.

TABLE II.

COLLEGIATE SCHOLARSHIP RATINGS OF 392 EMINENT ENGINEERS.

Class Rating.	A. S. C. E.		A. S. M. E.		A. I. E. E.		A. I. M. E.		Totals.	
	No.	%.	No.	%.	No.	%.	No.	%.	No.	%.
Highest 20 %	40	58.3	54	46.1	51	48.6	37	38.9	182	46.4
Second 20 %	21	28.0	30	25.6	27	25.7	31	32.5	109	27.8
Middle 20 %	8	10.7	24	20.5	19	18.1	21	22.1	72	18.3
Fourth 20 %	2	2.6	5	4.3	5	4.7	2	2.1	14	3.6
Lowest 20 %	4	5.3	4	3.4	3	2.8	4	4.2	15	3.8
Totals	75		117		105		95		392	

TECHNICAL TRAINING RESULTS.

There were 352 of the 392 men on the Registrars' eminent list whose class standing could be accurately obtained who were graduates of engineering schools and colleges. An analysis of these follows:

161 or 45.7 per cent. were in the highest fifth of their classes;

97 or 27.5 per cent. were in the second highest fifth of their classes;

65 or 18.4 per cent. were in the middle fifth of their classes;

14 or 3.9 per cent. were in the next to lowest fifth of their classes;

15 or 4.2 per cent. were in the lowest fifth of their classes.

FIVE ENGINEERING SCHOOLS.

A total of 189, or considerably more than one half of the engineering graduates on the Registrars' eminent list whose class rating could be accurately obtained, were graduates of five engineering schools and colleges: Columbia University, Cornell University, Lehigh University, Massachusetts Institute of Technology and Stevens Institute of Technology. It seemed well to analyze these results separately.

Of 189 representatives of these five institutions,

54 or 28.6 per cent. were in the highest fifth of their classes;

69 or 36.5 per cent. were in the second highest fifth of their classes;

50 or 26.4 per cent. were in the middle fifth of their classes;

9 or 4.7 per cent. were in the next to lowest fifth of their classes;

7 or 3.7 per cent. were in the lowest fifth of their classes.

Other Engineering Schools.

The following is a separate analysis of the 163 other men on the Registrars' eminent list whose class standing could be accurately obtained, representing forty-seven other engineering schools and colleges:

107 or 65.6 per cent. were in the highest fifth of their classes;

28 or 17.1 per cent. were in the second highest fifth of their classes;

15 or 9.2 per cent. were in the middle fifth of their classes;

5 or 3.1 per cent. were in the next to lowest fifth of their classes;

8 or 4.9 per cent. were in the lowest fifth of their classes.

Engineers Having Bachelor's Training.

Of the 392 representatives on the Registrars' eminent list whose class standing could be accurately obtained, forty were bachelor of arts or bachelor of science graduates who had no scholastic engineering education. They represented twenty-three colleges.

Of this group,

26 or 65.0 per cent. were in the highest fifth of their classes;

7 or 17.5 per cent. were in the second highest fifth of their classes;

7 or 17.5 per cent. were in the middle fifth of their classes;

None were in the next to the lowest fifth of their classes;

None were in the lowest fifth of their classes.

Comment on Class Rating Results.

The number and percentage results as to the class ratings of the 392 men on the Registrars' eminent list may be stated in other terms as follows:

Nearly one half of these professionally eminent engineers were in the highest fifth of their collegiate classes upon graduation—were scholastically eminent.

Nearly three fourths of these eminent engineers were in the higher two fifths of their collegiate classes upon graduation—were better than average students.

Only one out of twenty-five of these eminent engineers was in the lowest fifth of his collegiate class—was a student who was graduated with low rank.

The results on the totals in the four branches of engineering considered showed close correspondence.

Practically the same proportions held throughout for the 352 men on the eminent list who were engineering school and engineering college graduates.

For the five engineering institutions named elsewhere, having a total of 189 graduates on the eminent list, the proportions are different as to the upper scholastic fifths. The second highest fifth leads. The middle scholastic fifth representatives of these five institutions more nearly approach the two higher scholastic fifths. The two lower scholastic fifths have the same low percentage of representatives in these five institutions as in the other groups.

Considering the forty-seven other engineering schools and colleges with 163 representatives on the eminent list, the proportions of those who were scholastically eminent is high. The number of these in the highest fifth of their classes in these institutions was more than twice as large as in all other fifths put together.

The same proportion is found to exist among the forty representatives on the eminent list who had academic training and no scholastic engineering training. There were more than twice as many who stood in the highest scholastic fifth as in all other fifths. There were no representatives of

academic training who had low scholastic rating upon graduation.

With the purpose of eliminating any factor which might tend to weight the result toward high scholarship, statistics were made up omitting the 45 men of the 392 who hold teaching or college administrative positions. The class ratings remain substantially the same: Highest fifth, 43.5 per cent.; second fifth, 29.7 per cent.; middle fifth, 18.4 per cent.; next to lowest fifth, 4.0 per cent.; lowest fifth, 4.3 per cent. It should be said, in this connection, that most of the professors on this eminent engineers' list also have reputation as consulting or practicing engineers.

Carnegie Foundation Inquiry.

It is interesting to consider the results of this study of grades in connection with an inquiry conducted in 1915 by the Carnegie Foundation. The following circular letter was sent out to the then 30,000 members of the four founder engineering societies, the same societies whose officers, committee-men and representatives have been considered by the Collegiate Registrars Association:

"Please prefix numbers to the groups of qualities listed below to show the order of importance that you give them in judging the reasons for engineering success or in sizing up young men for employment or promotion.

———— Character, integrity, responsibility, resourcefulness, initiative.
———— Judgment, common sense, scientific attitude, perspective.
———— Efficiency, thoroughness, accuracy, industry.
———— Understanding of men, executive ability.
———— Knowledge of the fundamentals of engineering science.
———— Technique of practice and of business."

To this request more than 7,000 engineers replied. The character group of qualities was placed highest and knowledge and technique lowest in 94.5 per cent. of the replies. The percentage rating of the six groups was as follows:

TABLE III.

	Percentage.	
Character	24.0	
Judgment	19.5	
Efficiency	16.5	
Understanding of men	15.0	75
Knowledge of fundamentals	15.0	
Technique	10.0	25
		100

So decisive a vote as 94.5 per cent. of 7,000 opinions in favor of personal qualities as compared with purely professional qualities must be reckoned with.

It would seem, however, from the scholastic grade study that this popular opinion is over-enthusiastic in its three-to-one proportions. Knowledge of the fundamentals of engineering science is of course the aim of engineering schools. Of the engineering-school graduates on this eminent list 74 per cent. ranked upon graduation in the highest two fifths of their classes and accordingly had a knowledge of engineering fundamentals above the class average; less than 8 per cent. ranked in the lowest two fifths of their classes and accordingly had a knowledge of engineering fundamentals less sound than the class average. Knowledge of the fundamentals of engineering science, it seems safe to say, is clearly more important than the 15 per cent. assigned to it by popular engineering opinion. This opinion might have been distinctly different had those who expressed it been aware of the very high scholarship records of the men they elected to professional society leadership.

The vote emphasizing personal qualities in engineering leaders and this study attesting the intellectual powers of engineering leaders (as shown by scholarship rank and later achievement) taken together furnish an instance of positive correlation between intellect and character.

Extra-Scholastic Activities.

In addition to class standing information was sought as to the extra-scholastic activities of the eminent engineers in their

collegiate days. Registrars were asked to report specifically on activities in (*a*) athletics, (*b*) literary and engineering societies, and (*c*) social organizations.

Returns on these activities were received for about one fifth of the collegiate graduates, as compared with returns for more than two thirds on class rating.

In order to classify results, an arbitrary scale of rating was adopted as follows:

Under athletics, the rating A was assigned those who won letters in major sports; the rating B, those who played on first or second teams; the rating C, those who played on class teams; the rating D, those who took some part in athletics. The rating E was assigned for those not recorded as taking part in any form of athletics.

Under literary and engineering societies, the rating A was assigned those who held offices in societies or on editorial boards of literary or engineering journals; the rating B, those who actively participated in various ways; the rating C, those who participated moderately; the rating D, those who merely held membership. The rating E was assigned for those not recorded as being members of any engineering, literary society or similar activity.

TABLE IV.

EMINENT ENGINEERS.

Extra-scholastic Activities.

Rating.	Athletic.		Literary and Scientific.		Social.	
	No.	%.	No.	%.	No.	%.
A.....	24	13.5	59	31.5	44	25.7
B.....	14	7.9	19	10.2	11	6.4
C.....	19	10.6	22	11.8	50	29.3
D.....	4	2.2	22	11.8	10	5.8
E.....	117	65.7	65	34.7	56	32.7
Total.....	178		187		171	

Under social organizations, the rating A was assigned those who held office in class or social organizations; the rating B,

those who were active participants in such organizations; the rating C, those moderately active (fraternity membership in itself was regarded as entitling to this rating); the rating D, those who merely held membership in social organizations other than fraternities. The rating E was assigned for those not recorded as being members of any social organization.

Returns were received for 178 men in regard to athletics, 187 in regard to literary and engineering societies, and 171 in regard to social organizations. The distribution according to the foregoing arbitrary ratings is shown in Table IV.

Comment on Extra-Scholastic Activities.

It should be said promptly that the returns in regard to extra-scholastic activities were not satisfactory, either as to the number that could be reported or the completeness of those that were reported. The returns represent results only in so far as existing records, such as old year-books and class-books, show them. In consequence this part of the investigation has neither the accuracy nor the completeness of the results on class standing, based upon official collegiate records.

According to the table, two thirds of the men upon whom reports were made did not take part in athletics,—a proportion probably true for all college students in earlier days. Of those who did take part, the results show the largest percentage of men in the A rating,—good athletes.

According to the table, about two thirds of the men upon whom reports were made took part in literary and engineering society activities; of these the largest percentage were in the A rating,—were energetic in their activities along these lines.

According to the table, about two thirds of the men upon whom reports were made took part in social affairs. The largest percentage were moderately active; the next largest percentage were energetically active.

Conclusions can not safely be drawn from these extra-scholastic figures. The relatively small number of participants and the meager interest in athletics in the era

represented preclude generalization as to the influence of athletics, particularly as applied to present day college life when success in sports is so widely sought and so highly rewarded.

The figures as to all of the extra-scholastic activities are too indefinite for safe generalization. The one service they perform is by contrast to impress how definite and uniform for all groups considered are the results as to scholastic standing.

They thus reinforce the relationship between good scholastic work and good professional work in engineering.

Conclusions.

1. This study supplies evidence that, of students who begin collegiate courses, those who complete them have a much greater likelihood of engineering success than those who do not complete their courses.

2. This study supplies evidence that, of students who complete collegiate courses,

(*a*) those who rank high in their studies have a better likelihood of engineering success than average students,

(*b*) those who rank low in their studies have a poorer likelihood of engineering success than good students and average students.

FROM THE NOTEBOOK OF AN ENGINEER. II.

A Symposium on the Moment of Inertia.

BY R. FLEMING,

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Euler (1707–83) introduced the term "moment of inertia," and he explained its appropriateness (in his "Theoria Motus Corporum Solidorum," p. 167) somewhat as follows: The choice of the name, moment of inertia (Ger. tragheitsmoment) is based on analogies in the equations of motion for translations and rotations. In a translation the acceleration is proportional directly to the "accelerating force" and inversely to the mass, or "inertia," of the moving body; and in a rotation the angular acceleration is proportional directly to the moment of the accelerating force and inversely to a quantity, Σmr^2, depending on the mass or inertia. This quantity, to complete a similarity, we may call "moment of inertia." Then we have for translation and rotation respectively, linear acceleration = (force) / (inertia or mass); and angular acceleration = (moment of force) / (moment of inertia).—Maurer, "Technical Mechanics."

A copy of the original 1765 edition of "Theoria Motus Corporum Solidorum au Rigidorum" is in the New York Public Library. The accompanying cut is a reproduction of a portion of page 166.

Euler expresses his views on Inertia in one of his "Letters to a German Princess" (Letter LXXIV entitled "Of the Inertia of Bodies: Of Powers," dated November 8, 1760):

. . . This term was first introduced into philosophy by those who maintained that all bodies have a propensity to rest. They considered bodies as somewhat resembling indolent persons, who prefer rest to exertion, and ascribed to bodies an aversion to motion, similar to that which sluggards have for labour; the term *inertia* signifying nearly the same thing as

autem non tanquam quantitates variabiles seu indefinitae sunt spectandae; sed haec integralia per totum corporis molem extensa sunt intelligenda, ita ut obtineant valores constantes ac determinatos ab indole ac forma cujusque corporis pendentes. Ac binarum quidem priorum valores ex situ centri inertiae definiri vidimus: reliquarum vero valores ex natura corporis per notas integrationis regulas erui debent. Postremum autem imprimis est notatu digna, cum sola in accelerationem vel retardationem ingrediatur, dum reliquae tantum in expressionibus quae vires ab axe sustentatas indicant, intunt. Cum igitur hic quaestio de ipsa motus perturbatione sit praecipua, operae pretium erit, valores formulae $\int rrdM$ pro variis corporum generibus evolvere, ac praecepta tradere, unde illi quovis casu facillime colligi queant; interetum autem haec formula utique, ut ei nomen singulare [illegible] imponamus, cujus investigationi caput sequens destinamus.

CAPUT V.

DE MOMENTO INERTIAE.

DEFINITIO. 7.

422. *Momentum inertiae* corporis respectu cujuspiam axis est summa omnium productorum, quae oriuntur, si singula corporis elementa per quadrata distantiarum suarum ab axe multiplicentur.

COROLL. 1.

423. Quoniam tam elementa corporis, quam quadrata distantiarum semper sunt positiva, omnia haec producta pariter sint necesse est: hinc aucta corporis massa certe ejus momentum inertiae augetur.

COROLL. 2.

424. Momentum ergo inertiae spectari potest tanquam productum ex massa corporis in quadratum cujuspiam lineae: ita si massa corporis fuerit $= M$, ejus momentum respectu cujusvis axis habebit hujusmodi formam Mkk.

COROLL. 3.

425. Invento ergo momento inertiae corporis respectu axis, circa quem id ante gyrari assumsimus, idque fuerit $= Mkk$, in formulis supra inventis

sluggishness. But though the falseness of this opinion has been since detected, and though it is certain that bodies remain equally in their state of motion as in that of rest, yet the term *inertia* has been still retained to denote in general the properties of all bodies to continue in the same state, whether of rest or of motion.—Hunter's translation, 1802.

The integral $I = \int\int x^2 . dxdy$ is sometimes called the *moment of inertia* of the surface *AAA* relatively to the neutral axis, *YOY*. This is a term adapted from the science of Dynamics for reasons which will afterwards appear. . . . The Moment of Inertia of an indefinitely small body, or "physical point," relatively to a given axis, is the product of the mass of the body, or of some quantity proportional to the mass, such as the weight, into the square of its perpendicular distance from the axis. . . . By an extension of the term "moment of inertia," it is applied to the product of any quantity, such as a volume, or an area, into the square of the distance of the point to which that quantity relates from a given axis. . . .—Rankine, "Applied Mechanics."

It is obvious that the moment of inertia may be defined as the torque required to produce unit angular acceleration of one radian per second.—Catheart, "Physics for College Students."

Strictly speaking an area has no weight or inertia and therefore no moment of inertia, but it is customary to give the name "moment of inertia" to the quantity $\Sigma da \cdot z^2$. . . . The moment of inertia of a plane area contains the product of four linear dimensions and is hence expressed in quadratic units; for the sake of clearness "inches^4" will be used to designate the unit in which I is measured.—Merriman, "Mechanics of Materials."

The moment of inertia of a body with respect to an axis is the sum of the products obtained by multiplying the mass of each particle of the body by the square of its distance from the axis. If m is the mass of any particle, and r its distance from the axis; $I = \Sigma mr^2$. For a continuous body, the definition expressed mathematically is $I = \int r^2 dM$.—Boyd, "Strength of Materials."

At present no physical conception of moment of inertia can be given although later it will be shown that the term as applied to solids represents a quantity which is proportional to the velocity of rotation produced under certain conditions. As applied to the area, the moment of inertia is a numerical quantity only, entering into a large number of engineering

computations and takes its name from the analogy between the mathematical expression for it and that for the moment of inertia of a solid. . . . It is evident from the form of the above expression that the moment of inertia will always be a positive quantity, differing therein from the moment, which may be either positive or negative.—Fuller and Johnston, "Applied Mechanics."

The terms, *second moment of area, second moment of mass,* etc., would be preferable, but the term *moment of inertia* has been in use too long to be changed. In the case of areas the term is entirely misleading, for since an area has no inertia it can have no true *moment* of inertia.—Poorman, "Applied Mechanics."

We have defined inertia as the capacity of a body to possess momentum, and momentum as the product of mass and velocity. . . . The *second moment* of a volume or area is sometimes termed the "moment of inertia" of the volume or area. Strictly, this term should only be used when dealing with the inertia of bodies; but in other cases, where the second term has nothing whatever to do with inertia, the term second moment is preferable.—Goodman, "Mechanics Applied to Engineering."

Engineers call $\int x^2 dA$ the *moment of inertia* of the section of the beam. The term *moment of section* is however the correct term.—Franklin, MacNutt and Charles, "Calculus."

Because the element of area is multiplied by the *square* of its distance from the Y axis it is sometimes called the *second moment,* to conform with the definition of moment of area.—Granville, "Differential and Integral Calculus."'

The term "Moment of Inertia" originated in a wrong conception of the properties of matter. The term has, however, been retained as a very convenient one, although the conceptions under which it originated have long ago vanished.—Lanza, "Applied Mechanics."

. . . Σbty is the simple moment of an area about an axis. Σbty^2 may be called the moment of the second degree, but the common name is the *Moment of Inertia,* because a similar name (differing only from this in involving the mass) occurs in dynamics under that name.—Cotterill, "Applied Mechanics."

. . . This integral is sometimes called "The Second Moment of the Surface," but the more common name is "The Moment of Inertia of the Surface." . . . The name "second moment"

would appear to be more logical than the "moment of inertia." . . . However, the term, "moment of inertia" is in good use and will be retained as well as the mysterious term "radius of gyration."—Woodward, "Rational and Applied Mechanics."

Since the I of a plane figure evidently consists of *four dimensions of length*, it may always be resolved into *two* factors, thus $I = Fk^2$ in which F = total area of the figure, while $k = \sqrt{I \div F}$, is called the radius of gyration.—Church, "Mechanics of Engineering."

Multiply each layer by the square of the distance from the axis to the center of gravity of the layer and add the products. Thus is obtained the Moment of Inertia, an expression denoting the disinclination of the body to move as a whole.—McCullough, "Structural Design."

Formerly it was believed, however, that all matter had a certain repugnance to being moved, which had to be first overcome, before a body could be moved. Probably in connection with some such theory the term arose. In reality matter is perfectly indifferent whether it be in motion or in a state of rest, and this indifference is termed "Inertia." As used today, however, the term Moment of Inertia is a symbol or name for a certain part of the formula by which is calculated the force necessary to move a body around a certain axis with a given velocity in a certain space of time; or what amounts to the same thing, the resistance necessary to stop a body so moving.—Bergh, "Safe Building Construction."

The present writer considers quite expressive the comment (handed him by Professor Moore of the University of Illinois) given by Professor Albert Kingsbury to his classes in Mechanics in New Hampshire State College in 1896:

The so-called moment of inertia to any area is not a moment in the ordinary sense and has nothing to do with inertia. It may best be thought of as a group of mathematical factors, $\int r^2 dA$, frequently used in mechanics of materials.

A few years ago the writer received a pamphlet, "Haze and Moonshine in Statics," being an extract from an address delivered before the St. Louis Architectural Club, March 6th, 1913, by Philip J. Markman. The author thinks that the term under the $\int$ sign, though it represents the sum of all

elementary areas multiplied by the squares of their respective distances from the neutral plane, is a geometrical quantity of one dimension, a distance or a length. "It is a quantity measured with a yard-stick. . . . Or, restating it, the f term represents the *arm* of a couple whose common force is the *unit stress at the unit distance* from the neutral plane and whose moment is equal to and balances the bending moment."

The author's line of thought will be given almost in his own words in considering the strength of a 20-inch, 65-pound I beam. The table in the handbook shows that for this beam $I = 1{,}169.5$ and section modulus $= 117$. Therefore, the greatest bending moment it is able safely to resist is, taking $f = 16{,}000$ pounds,

$M_{max} = 16{,}000 \times 117 = 1{,}871{,}200$ inch-pounds or knowing that S (the "unit stress" at the "unit distance" below or above the neutral plane) $= f/n = 16{,}000/10 = 1{,}600$ pounds, we may also write,

$M_{max} = 1{,}600 \times 1{,}169.5 = 1{,}871{,}200$ inch-pounds.

In an I beam section, the material is largely placed in the flange, and the resultants of the compressive and tensile stresses may, for this beam, be approximately assumed to fall within 1 inch of extreme fibers; the arm of the internal stress couples, under this assumption, would be approximately 18 inches, and therefore,

1,871,200/18 = approximately 104,000 pounds,

the resultant of the compressive stresses and tensile stresses, respectively. This internal stress couple (force = 104,000 pounds, and arm = 18 inches) is the *"real"* couple which balances the external forces. The couple 16,000 pounds $\times$ 117 inches is an *"ideal"* couple whose *"ideal"* force is the rate of stress at the extreme fiber and whose *"ideal"* arm is the section modulus, while its moment is equal to the moment of the *"real"* couple. The couple $1{,}600 \times 1{,}169.5 = 1{,}871{,}200$ is another *"ideal"* couple, whose *ideal* force is the rate of stress of the fiber at the unit distance from the neutral plane and whose *"ideal"* arm is the I (the so-called moment of in-

ertia), while its *moment* is also equal to the *moment* of the *"real"* couple.

In "Structural Steelwork," an English book by Ernest G. Beck, the section modulus, moment of inertia and radius of gyration are considered as leverages. The author calls attention in the preface to his attempt to present them in a form that will allow them to be visualized by any ordinary student. Stated mainly in the language of the book his method is as follows:

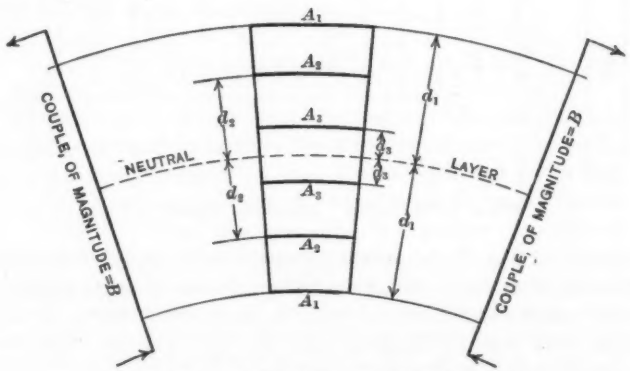


FIG. 1. From Beck's "Structural Steelwork."

From Fig. 1 we may obtain the familiar relation:

$$B = f_1a_1d_1 + f_2a_2d_2 + f_3a_3d_3 + \ldots . \quad (1)$$

In this expression B represents the bending moment in inch-pounds; a_1, a_2, a_3, . . . are the numbers of square inches in the cross-sectional areas of the strips A_1, A_2, A_3, . . . , respectively; d_1, d_2, d_3, . . . are the distances (in inches) of the strips A_1, A_2, A_3, . . . (respectively) from the neutral layer; and f_1, f_2, f_3, . . . are the intensities (in pounds per square inch) of the stresses in the strips A_1, A_2, A_3, . . ., respectively.

Suppose the plane section were a thin but rigid sheet, 1 in. in breadth, subjected to the action (a rotational tendency) of

a disturbing couple P pounds at D inches $= PD$ inch-pounds; and instead of the stresses in the material, imagine the resistance to rotation provided by the weights of suitable rods, each 1 in. square in section. The conditions might then be as in-

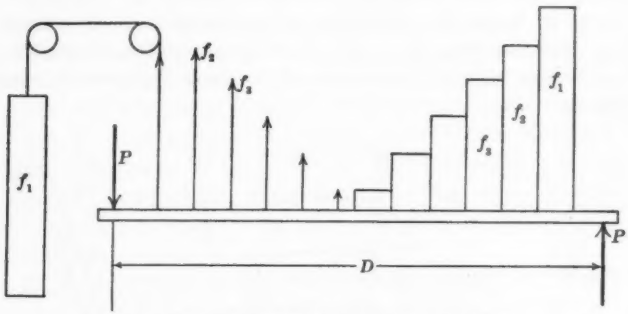


FIG. 2. From Beck's "Structural Steelwork."

dicated in Fig. 2, the upward (representing tensile forces to the left of the axis) being applied by means of cords passing over pulleys and carrying rods at their other ends. If all these rods were of the same material, their lengths would be proportional to their weights, that is as $f : f_2 : f_3 : \ldots$

The stress intensities in the various layers are proportional to their distances from the neutral layer, that it $f_1 : f_2 : f_3 : : d_1 : d_2 : d_3$.

Whence

$$f_2 = f_1\left(\frac{d_2}{d_1}\right); \quad f_3 = f_1\left(\frac{d_3}{d_1}\right);$$

and so on.

Substituting in Eq. (1):

$$B = (f_1 a_1)d_1 + \left[f_1\left(\frac{d_2}{d_1}\right)a_2\right]d_2 + \left[f_1\left(\frac{d_3}{d_1}\right)a_3\right]d_3 + \cdots. \quad (2)$$

Eq. (2) might be written:

$$B = f_1\left\{a_1(d_1) + \left[a_2\left(\frac{d_2}{d_1}\right)\right]d_2 + \left[a_3\left(\frac{d_3}{d_1}\right)\right]d_3 + \cdots\right\}. \quad (3)$$

The reasoning of the author is that each term within the { } brackets is an imaginary, but perfectly logical and practicable, leverage; and the sum of all these terms must, therefore, be a similar leverage. This leverage is called the "Section Modulus."

Again, suppose we took the couple of Eq. (3) and increased the arm by repeating it to as many times as there are inches in d_1, at the same time correspondingly reducing the two forces so that the magnitude of the couple remained unaltered. The relation would then become:

$$B = f_1\left(\frac{1}{d_1}\right)\{(a_1d_1)d_1 + (a_2d_2)d_2 + (a_3d_3)d_3 + \cdots\}. \quad (4)$$

The expression within the { } brackets represents another leverage, the arm of another couple (equivalent to the resistance moment) formed by two forces, each of magnitude $[(1/d_1)f_1]$ pounds, and this leverage is called the "Moment of Inertia." From this reasoning the author thus defines Moment of Inertia (with regard to beam sections):

If the actual resistance moment of a section were replaced by an equivalent couple in which the forces were each $[(1/d_1)f_1]$ pounds—*i.e.*, the weight obtained by cutting one complete extreme-fiber-stress-bundle into as many parts as there are inches in the distance between the neutral and extreme layers, and taking the weight of such part to form each force of the couple—the arm of that equivalent couple would be the Moment of Inertia.

Beck does not think any real improvement would result from a change of names:

It matters little what we call a thing so long as the name we use for it is in common acceptance (or is commonly acceptable) and provided always that we clearly understand what the *thing itself* really means to us. One improvement should be sought, however, and that is the abolition of the erroneous and misleading statement that Moment of Inertia is measured in "inches to the fourth power," and Section Modulus in "inches to the third power." All three—Section Modulus, Moment of Inertia and Radius of Gyration—are, as we have shown, merely distances. They are imaginary (in the same sense as is the height of a building not yet erected,

or the average width of an irregular field), but are nevertheless entirely practicable and reasonable as the "arms of equivalent couples." All three should, therefore, be stated as "in inches."

To the present writer the unanswerable argument against I being linear inches is that dividing by 12 will not express it in feet. For instance, the I of a 6 x 12-in. timber about an axis through center of cross section is

$$\frac{bh^3}{12} = \frac{6 \times 12^3}{12} = 864 \text{ in.}^4$$

Expressed in feet it is

$$\frac{0.5 \times 1^3}{12} = 0.0416 \text{ ft.}^4$$

If the 864 were linear inches the I would be $864 \div 12 = 72$ ft., but being quadric inches it is $864 \div 12^4 = 0.0416$ ft^4.

Methods of determining the moment of inertia graphically are given in many textbooks. An early (perhaps the earliest) method is that found in Ott's "Die Grundzüge des graphischen Rechnens und der graphischen Statik." The author's preface to the first edition of this small but interesting book is dated July, 1870. The third edition was published in 1874. Clarke's translation with the omission of the graphical arithmetic was published in London, 1876, under the title: "The Elements of Graphic Statics." Ott's method is also given in Church's "Notes and Examples in Mechanics," 1892.

The method is as follows: Divide the shape in question, Fig. 3 (a) into strips parallel to BC. Through the centers of gravity of the strips draw indefinite lines f_1, f_2, etc. Along a line ab parallel to f_1, f_2, etc., lay off lengths f_1, f_2, etc., proportional respectively to the areas f_1, f_2, etc. (when the strips are narrow and of equal width each such strip may be assumed proportional to the length of the strip measured through the center of gravity). Through a and b draw lines at 45 degrees with ab to determine the pole O, from which the rays Od, Oe, etc., are drawn. Construct the equilibrium poly-

gon *gsf*. A line *sS* parallel to *BC* will be a gravity axis. The moment of inertia about this axis is equal to the area of the given figure *ABC* multiplied by the area of the polygon *gsf*. The square root of this area *gsf* is the radius of gyration of the figure *ABC* with regard to the axis *sS*.

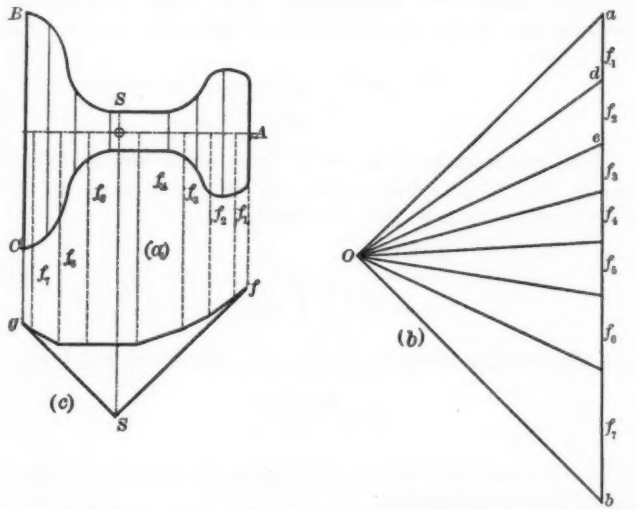


FIG. 3. From Ott's "Die Grundzüge des Graphischen Rechnens und der Graphischen Statik."

"Why do you not make more use of the polar moment of inertia?" asked a college professor of the writer. "You tear yourself to pieces deriving an equation for the wind stress in a cylindrical steel stack or the uplift in an anchor bolt when by using the polar moment of inertia the same results could be obtained with less work." The professor had reference to an article in the *Engineering News-Record*, Vol. 83, Sept. 11, 1919, page 499, and to an editorial discussion in the *Engineering News*, Vol. 71, Apr. 30, 1914, page 957. The professor's idea may be illustrated as follows:

Let r be the radius and t the thickness of the shell of a steel stack. The polar moment of inertia, Ir, for a section of ring of unity length is tr^2 and for the whole ring is $2\pi r \times tr^2 = 2\pi tr^3$. If referred to rectangular axes, $Ix = Iy = \frac{1}{2}$ of $2\pi tr^3 = \pi r^3 t$, since the polar moment is equal to the sum of the moments about two rectangular axes. The fundamental formula for flexure is $M = S(I/c)$, and since $c = r$, $M = S\pi r^2 t$, or

$$S = \frac{M}{\pi r^2 t}. \tag{1}$$

If M, the moment of the wind force above any horizontal section, be given in foot-pounds and D, the diameter of the stack be given in feet, Eq. (1) becomes

$$S = \frac{M}{\pi \times 12\left(\frac{D}{2}\right)^2 \times t} = 0.106\frac{M}{D^2 t} \tag{2}$$

and the bending stress in pounds per circumferential inch,

$$St = \frac{0.106M}{D^2}. \tag{3}$$

This is the equation for the wind stress in a cylindrical stack at any horizontal section.

Again: Let N = number of anchor bolts, $D = 2R$ = diameter of bolt circle, a = area of one bolt, S = unit stress in bolt and $Sa = T$ = total uplift from wind in one anchor bolt. The polar moment of inertia, Ir, of all the bolts is

$$aN \times \left(\frac{D}{2}\right)^2 = \frac{aND^2}{4}. \tag{4}$$

As before, if referred to rectangular axes,

$$\tfrac{1}{2}Ir = \tfrac{1}{2} \text{ of } \frac{aND^2}{4} = \frac{aND^2}{8}. \tag{5}$$

In the fundamental formula for flexure, $Sa = T$, $D/2 = R = c$ and substituting for I we have

$$M = S\frac{I}{c} = \frac{SaND^2}{8R} = \frac{TNR}{2} \quad \text{or} \quad T = \frac{2M}{NR}, \tag{6}$$

the uplift in each bolt due to wind. Deducting the weight of the stack, W, divided by the number of the anchor bolts, N, there results,

$$U = \frac{2M}{NR} - \frac{W}{N}, \tag{7}$$

the net uplift in pounds in each anchor bolt.

DISCUSSION.

In the October number of your Bulletin, Mr. Rudolph Hering has replied briefly to my paper on "The Classics for Engineers." I request permission to comment briefly in turn, disavowing, however, any desire to fill your columns with a controversy which is probably more apparent than real.

In the first place, Mr. Hering's own title for his first paper, "Latin and Greek not Essential for Engineering Knowledge and Practice," represents a conception of the classics so different from "Latin and Greek not Best for Engineers" that the distance separating us is now not as great as it seems. As I am not a believer in compulsory Latin, though a teacher of Latin, I should hesitate to claim that Latin is essential for an engineer in any phase of his engineering activity. Nevertheless, Professor F. V. Larkin, head of the department of mechanical engineering in Lehigh University, constructing a college course in industrial engineering before the Society of Industrial Engineers, on November 10, 1920, specified two years of Latin among the entrance requirements for that course. My contention, throughout my paper, was not that the engineer as engineer needed Latin and Greek as part of his professional training, but that the engineer as a human being needed the training in language, the discipline, the vision, which a study of Latin or Greek may impart. The study of the ancient languages is a privilege, from which I would not willingly exclude any one who showed promise of deriving benefit therefrom. The subject matter contained in the works of classical authors is available in other forms, but no substitute can be found in translations for the training in the use of language. Few exercises can be as useful in cultivating exactness and propriety in the use of language as translation from another language into English. Attention, discrimination and judgment are constantly necessary.

My limitation of the term "classics" to Latin and Greek was deliberately made because Mr. Hering had apparently

made it before me. I apologize for attributing to Mr. Hering the word "objection." Perhaps we are in entire agreement in our objections to the method that has been in use. But this method, Mr. Hering will be glad to know, is undergoing constant and thorough revision, and the old lifeless, mechanical teaching of the ancient languages may be regarded as a thing of the past. Latin teachers are everywhere accomplishing the things Mr. Hering desires. That the same thing is happening in Greek, Professor Hoffman's book (to which I referred on p. 365) is evidence.

My conception of mental discipline is hazy, because no psychologist at present can say positively that such a thing exists and what its nature is if it does exist. The extent to which the mind can be trained is a matter of debate. My definition of discipline is not that which Mr. Hering gives. The discipline of Latin is not "a training to act in accordance with laws and regulations." Nor, for educational purposes, can I quite accept the military conception of discipline. I mean rather by the word the ability and the habit of following a mental process through to the end. Not only thinking, but straight thinking, is demanded. I still believe that the average Latin teacher is thinking more consciously than the average science teacher, of the growth of his students in intellectual power. Teachers of mathematics seem to be less certain than Mr. Hering of the value of their subjects in mental discipline. Thus, in the Bulletin (1920, No. 1) of the Bureau of Education on The Problem of Mathematics in Secondary Education, the following statement is made: "The psychologists, however, have so far found it difficult to agree upon any final situation as to the amount of transfer which in any particular situation may be a priori expected. All agree, none the less, in greatly reducing the old claim, both as to the amount and as to the generality of conditions under which transfer may be expected. In accordance with these considerations the committee has not used the factor of 'formal discipline' in determining the content of the mathematics courses to be recommended in this report" (pp. 16–17). This is not of course a surrender

on the part of the teachers of mathematics, but merely an admission that the amount of mental training to be derived from mathematics is debatable. But the Latin teacher, to repeat, is not primarily interested in training the mind to follow without variation certain paths. If the discipline of mathematics and logic be superior in dealing only with "absolute certainties," and the discipline of science be next in value, because it deals with "absolute certainties and relative certainties obtained by induction," we may still with due modesty believe that there is value in the ancient languages, which aim to train the mind to work effectively even where the materials are less perfect, and it may be true that with human materials a lower degree of perfection may be expected than with nature. In proportion to the greater variability of linguistic laws as compared with natural, some one might claim (I do not, at present) that linguistic training might fit one better to cope with the emergencies and the unexpected things of life.

My statement regarding the origin of the scientific spirit was slightly misleading. In its modern aspect it dates from the classical studies of the Renaissance. It does appear of course in Aristotle, but its recovery and its application after the Dark Ages was the work of the scholars of the Renaissance.

Mr. Hering's final paragraph convinces me that we are really close together in our views. His picture of the man of culture is so much like my own that I can not think that we are in fundamental disagreement. I was very glad, too, to have my suspicion verified that Mr. Hering had once studied Greek. I can assure him that the marks of his classical training are clearly apparent, and I do not believe that he could have presented the case against the classics so vigorously and so forcibly without that training. If Mr. Hering can and will continue his efforts to convince the world that it needs the classical training he describes in his closing paragraph we shall count him among the most valuable of our allies.

EVAN T. SAGE.

EDITORIAL.

The matter that is most prominent in the Editor's mind at this time of the year is the annual gathering of engineering teachers at the meeting of this Society. These meetings have been held continuously since the World's Fair in Chicago. They have been attended by all the prominent engineering educators of the United States and by many from foreign countries. The meeting presents the opportunity for the presentation of new ideas and thorough discussion with colleagues. The social features are looked forward to by those who attend with great anticipation.

Yale University is, for the first time in the history of the society, the host. One of the oldest of American collegiate institutions, it has tradition, buildings and associations which appeal to the best in American life. On the other hand, Yale presents in the Sheffield Scientific School of Applied Science some of the most modern ideas in engineering education. Its recent change from a three-year to a four-year course, additions to its faculty, its new laboratories, and especially the spirit which pervades the schools, should be a source of inspiration to everyone who has the pleasure of attending this meeting.

The Local Committee has made arrangements which it would be difficult to improve. Special opportunities will be given for social intercourse and it is proposed to have the program sufficiently diversified, and the papers sufficiently short so that there may be greater opportunity for discussion.

The motto of the Local Committee is "Come to Yale in Historic New Haven, the City of Old Elms and New Ideas."

COLLEGE NOTES.

Carnegie Institute of Technology.—Dr. J. E. Rush, of the Department of Sanitary Egineering, addressed the captains of the first aid teams of the Bell Telephone Company on February 15, on "Applications of Hygiene to the Telephone Industry."

Mr. Samuel E. Dibble, of the Department of Heating and Ventilating Engineering, has lately been appointed a member of the Research Bureau Committee of the American Society of Heating and Ventilating Engineers, and, in this capacity, has been delegated to investigate drafts in chimneys for low-pressure boilers. The materials for the experimental investigations, which will be carried on at the school, have been donated by the Clay Products Association and the International Heater Company.

Professor Fred Crabtree, head of the Department of Mining and Metallurgical Engineering, attended the meeting of the Institute of Mining and Metallurgical Engineers in New York on February 14–15–16. While in New York, he attended also the meeting of the joint committee on research in drilled steel.

The Citadel.—Upon the retirement of Major R. G. Thomas, professor of mathematics and engineering, at the end of the past session, the department was divided into the Department of Civil Engineering and the Department of Mathematics. Major L. S. Le Tellier, for a number of years in charge of the work in engineering drawing, was elected professor and head of the department of civil engineering, and Col. O. J. Bond, superintendent of The Citadel, has taken over the duties of directing the Department of Mathematics and of teaching advanced mathematics. Capt. John Anderson, formerly assistant professor of engineering drawing, was elected associate

professor of civil engineering. Major Thomas retired, after thirty years of service, on account of ill health.

The college hopes to move into its new plant at the beginning of next session. The large barracks building, to accommodate 420 cadets, is nearing completion and good progress is being made on the other buildings. The new plant is located on the Ashley River on the outskirts of the city of Charleston. The work is in charge of Lockwood, Green & Co., and when completed will be one of the most modern college plants in the country. In the new buildings, the facilities for laboratory instruction in civil engineering will be vastly improved.

Cornell University.—Heretofore the different departments of engineering instruction at Cornell University were included in two separate colleges: The College of Civil Engineering, and the Sibley College of Mechanical Engineering. On January 8, 1921, the Board of Trustees of the University took the last action of a series extending over a period of two and a half years, which officially organized a new College of Engineering to be composed of the School of Civil Engineering, the Sibley School of Mechanical Engineering, and the School of Electrical Engineering.

The first meeting of the Faculty of the College of Engineering was held on February 21. This faculty will deal with matters relating to more than one school. Each of the schools will have its own faculty meetings to consider matters relating exclusively to that school. While the consolidation of the two former colleges went into effect with the opening of the second semester, the course of study for all engineering students during the freshman year, and which had been adopted previously, went into effect at the opening of the academic year, last fall.

Professor Dexter S. Kimball, the new dean of the College of Engineering, was elected to this office more than a year ago. Upon the nomination of Dean Kimball the University board of trustees elected Professor Fred. A. Barnes, Herman Diederichs, and Alexander M. Gray as directors respectively

of the three schools named in the first paragraph of this article. The directors of the schools will assist the dean and perform such duties as may be assigned to them from time to time.

The former dean of Sibley College, Professor Albert W. Smith, is on sabbatic leave for the present semester and will retire next June. He is serving the University as acting president for the academic year. The former dean of the College of Civil Engineering, Professor Eugene E. Haskell, is also on sabbatic leave of absence for the present semester and will retire next June.

Lafayette College.—The following new appointments were made in the Engineering Departments at the beginning of the present college year.

Department of Mining Engineering.—William Bertolette Plank has been appointed professor and head of the Department of Mining Engineering, and George B. Markle, professor of mining engineering.

Department of Civil Engineering.—Harry T. Spengler has been appointed associate professor and head of the department. William B. Marquard, formerly assistant professor of mining engineering, has been made associate professor of mechanics. William S. Lohr has been appointed associate professor of civil engineering.

Department of Mechanical Engineering.—John B. Prior was appointed instructor in mechanical engineering. Thomas E. Yerger, of Easton, Pa., has been appointed instructor in mechanical engineering shop, and college organist. Mr. Yerger comes to Lafayette from the Lehigh Valley Railroad.

Department of Electrical Engineering.—Morland King was appointed associate professor and head of the department. Don Price was appointed instructor in electrical engineering.

Department of Chemical Engineering.—Luther B. Witmer was appointed assistant professor of metallurgy. Dr. Witmer is a graduate of Franklin and Marshall College and of the University of Pennsylvania, where in 1906 he received the de-

gree of Ph.D. He comes here from the United States Bureau of Standards.

Lehigh University.—William S. Murray, of New York, originator of the super-power electric system for which Congress recently made a large appropriation, gave two addresses at his alma mater, Lehigh University, March 10 and 11, before the student electrical engineering society and engineers of the section around Bethlehem and before the faculty and entire student body. Mr. Murray discussed engineering and economic aspects of the super-power project.

"The Railroad Society of Lehigh University" is a new group, organized by undergraduates in the engineering courses who look forward to railroad work.

Marquette University.—For a period of two years Marquette University has been operating under the coöperative system of engineering education. The system as installed here consists of two weeks at school followed by two weeks in the shops. The shop work has been laid out in conjunction with the industries in as careful a manner as is the school work, the main exception being that the student does not necessarily *start* in some one department before he has experience in the others. For a university in this location, the system works out admirably and has so far proven entirely satisfactory. The present industrial depression has, however, thrown out of employment about 40 students which has necessitated our establishing a special course in which the students out of work are given a straight course in school which will be followed by a period in the shops. This really amounts to merely changing the length of the periods for these few students.

Coincident with the establishment of this course, we also extended our general and business education requirements to the extent of requiring each student to belong to and attend the meetings of their own Engineering Association of which we have but *one*. One credit hour is granted for this each

term, two per year, and in case of failure to earn this, the student must make an extra credit before graduating. In addition to the regular English given in the freshman year, all future reports on laboratory experiments, etc., are graded for the English used, one credit per term being given for this. In the last two years of the course we have included such subjects as economics, commercial law, accounting, corporation finance, etc., which courses are taught by the College of Economics.

Purdue University.—Important changes in curricula to go into effect next year have been approved by the faculty of Purdue University as follows:

1. Modern language courses made elective in civil, electrical and mechanical engineering courses.

2. A non-technical elective course, 3 credit hours per week, running through all four years in the courses in civil, electrical and mechanical engineering.

3. An orientation course in engineering problems, one credit hour per week, running through the freshman year in the courses in civil, electrical and mechanical engineering.

4. Surveying for civil engineering students shifted from the sophomore year to the second semester of the freshman year. This course will be followed by practice work in a summer camp held between the freshman and sophomore years. The work in surveying is to be continued during the first semester of the sophomore year. It will be followed in the second semester of the sophomore year by a course in general engineering projects.

5. A course in engineering administration, 3 credit hours per week during the second semester for seniors in civil, electrical and mechanical engineering.

The orientation course in engineering problems for freshmen and the course in enginering administration for seniors will be administered under the direct supervision of Dean A. A. Potter, who will in addition to his other duties act as head of the department of general engineering. He will be

assisted by the heads and professors of the other engineering schools and departments. The orientation course for freshmen is not a lecture course, but a real engineering problem course with particular emphasis placed on the engineering problems arising from community needs. A special effort will be made in this course to give the freshman students personal contact with the older and more experienced engineering teachers.

A new system of personality grading of students has been inaugurated by Dean Potter who, in connection with this work, has received hearty coöperation from the Indiana Manufacturers, Association. A description of the system, the aims which it is expected to achieve and some experience in its operation will form the basis of an article to be presented at some future date.

The state legislature recently materially increased the mill tax from which the university derives the bulk of its financial support. It is hoped that the new tax will approximately double the income of the university.

In order to provide space for the greatly increased number of engineering students plans are being drawn up for the following building extensions:

1. Electrical Engineering Building—Laboratory extension and class rooms.
2. Civil Engineering Building—Class rooms and a new laboratory for materials of construction.
3. Mechanical Engineering Building—Enlargement of the present building to provide more class and drafting rooms.

Within the next three years it is planned to make material extensions to the present wood, foundry, forge and machine shops. Believing that good scholastic work is as worthy of publicity as successful athletic work, Dean Potter is inaugurating a plan for giving some publicity to the attainments of those students who excel in scholarship. Reporters have been appointed from the staffs of the several engineering schools. It is the duty of these reporters to follow up the scholastic

records of the better men. When a student's record indicates unusually high scholarship, a suitable news story is written up concerning him. This is sent for publication to the student's home town paper, a local paper, and the student publication at the University. The papers are very glad to print these stories.

Dean C. H. Benjamin, dean emeritus of the Engineering Schools, is spending the winter in Pasadena, California. Dean Potter assumed the duties of director of the Engineering Experiment Station, November 1, 1920.

Courses in aërodynamics and refrigeration have been added to the elective courses available to the seniors in mechanical engineering. A research on the effect of "hot spots" in the intake manifold of an automobile engine has yielded much valuable information on the subject of carburetion. The results of this research are being published in the form of a bulletin by the Engineering Experiment Station. A series of tests on army tractors is being run in the tractor testing laboratory.

Tests on such insulators as manufacturers are now able to provide for 220,000 volt transmission line service are being made in the high voltage laboratory of the School of Electrical Engineering. The university radio plant, under the supervision of Prof. R. V. Achatz, has been coöperating with the Bureau of Standards in connection with some radio transmission tests and with other university radio plants in the Middle West in transmitting news of intercollegiate athletic games.

Professor Alfred Still has recently published a new edition of his well-known book on Electrical Design.

In the School of Civil Engineering a research on the concrete making properties of Indiana sands and gravels has been completed. This research has resulted in a change of the Indiana specifications for concrete roads and increased the output of the gravel and sand plants. Certain lines of the research are being continued through a coöperative agreement with the Federal Bureau of Roads. The results of the research

have been published in the Proceedings of the American Concrete Institute. In the same periodical Dr. W. K. Hatt has recently published the results of a test on a concrete mixer and of an investigation of the consistency and strength of concrete as affected by time of mixing, speed of rotation, and time of introduction of different amounts of water.

Prof. F. W. Greve has recently completed an extended research on a new form of parabolic weir for measuring water. The results of this research have been published in the proceedings of the American Society of Civil Engineers.

Rhode Island State College.—The engineering societies of **Rhode Island State College** have been united into one society which meets regularly once a month. At these meetings, papers are presented and discussions held by the members on subjects that are of interest to all students engaged in the three lines of work, *i.e.*, civil, electrical and mechanical. Supplementary meetings are held on other dates, at which an educational movie is presented, dealing with some phase of engineering work.

Agricultural and Mechanical College of Texas.—*Resignations,* effective August 31, 1920.

Roy M. Green, professor of highway engineering, to become manager of the Western Laboratories, 132 North 12th Street, Lincoln, Nebraska.

A. C. Love, professor of railway engineering, to become District Engineer for the Texas State Highway Commission. Present address, Bryan, Texas, or Care State Highway Dept., Austin.

E. E. McAdams, associate professor of civil engineering, to become business manager for the city of Bryan, Texas.

W. T. Donoho, instructor in civil engineering, to become assistant engineer, G. C. & S. F. Ry., headquarters at Temple, Texas.

Appointments, effective September 1, 1920.

W. J. Emmons, professor of highway engineering. Formerly

with the Pittsburg Testing Laboratories at Birmingham, Alabama.

B. D. Marburger, professor of railway engineering. Formerly District Engineer for the M. K. & T. Ry., Smithville, Texas.

T. A. Munson, associate professor of civil engineering. Formerly in private civil engineering practice at Angleton, Texas.

J. L. Lochridge, instructor in civil engineering. Formerly assistant engineer in charge of duty of water investigations coöperatively conducted by the U. S. Department of Agriculture, Bureau of Rural Engineering, and the Texas State Board of Water Engineers.

C. C. Braden, instructor in civil engineering. Formerly instructor in Drawing, A. & M. College of Texas, and later assistant engineer on highway construction, Polk County, Texas.

J. T. L. McNew, instructor in civil engineering. Formerly assistant engineer, City of Beaumont, Texas.

Only three holdovers remained in the department. These were, J. C. Nagle, professor of civil engineering, head of the department; J. J. Richey, professor of structural engineering, and Byron Bird, associate professor of highway engineering. Exceptionally attractive opportunities to the other members of the former teaching staff of the department accounts for the heavy percentage of resignations.

Physics Department.—In September, 1920, the Department moved into a handsome new building which was constructed for the sole use of that department at a cost of $100,000. This department has heretofore shared the civil engineering building which was built in 1909. The space released by the removal of physics affords much needed relief to the civil engineering department which has heretofore been greatly cramped and in need of the additional space.

The University of Wisconsin will hold an exposition from April 21 to 23, for the purpose of putting before the citizens of the state, in a compact and interesting form, the multifarious activities of the institution. The exposition, which will be held in the university gymnasium, is being handled by a committee of students. The space available will be allotted to the various departments, and each department will arrange its own exhibit.

This will be the second exposition that the University has attempted. The former one, held in March, 1915, was entirely successful and was a revelation even to members of the faculty who had been on the campus many years. An exposition is an annoyance in many ways, and should not be undertaken oftener than once in five years or so. It is a heavy burden for the students, and the necessity for using certain laboratory equipment in the show interferes somewhat with instructional work.

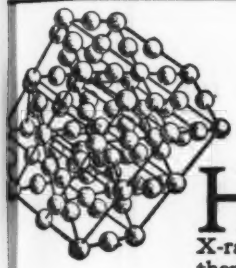
Two men have been added to the staff of the mining department this semester. Joseph Oesterle, a Wisconsin graduate, has been appointed research professor of metallurgy. He comes from the metallurgy division of the Bureau of Standards. George J. Barker, appointed instructor in mining, has been in the research department of the Great Falls plant of the Anaconda Copper Co.

BOOK REVIEW.

Cam Design and Manufacture. By F. B. JACOBS. D. Van Nostrand Company. 87 illustrations, 121 pages. Price, $2.00.

A practical treatise on some of the forms of open, wiper and patch cams, with pointers on laying out cams from motion curves. One chapter is devoted to the method of procedure in laying out a gas-engine cam and a discussion of several good and poor gas-engine cam outlines. A few common types of followers are shown, giving the good and bad points of each; also rollers and their method of support, preparing rollers by lapping, and types of rocker followers. There are chapters on laying out master cams of several of the cam outlines discussed in the fore-part of the book, preparing the cam for finish cutting, some fixtures and machines used in cam cutting, cam milling cutters, some points on cam cutting, and a discussion on cam grinding.

W. F. W.



Who Was Moseley?

HE was a young Oxford man, only twenty-seven when he was killed at Gallipoli. Up to his time, man had never seen the inside of an atom. He turned the X-rays on matter—not figuratively but literally—and made them disclose the skeleton of an atom just as certainly as a surgeon makes them reveal the positions of the bones of the body. Moseley proved that all atoms are built up of the same kind of matter. He saw, too, just why an atom of copper is different from an atom of gold.

Atoms are built up of electrons. Each atom consists of a nucleus, a kind of sun, with a certain number of electrons grouped about it, like planets. Moseley actually counted the number of electrons of all the metals from aluminum to gold.

When you discover what gold is made of or a new fact about electricity, you open up new possibilities for the use of gold or electricity. For that reason the Research Laboratories of the General Electric Company are as much concerned with the "how" of things—atoms and electrons, for instance—as they are with mere applications of the electric current.

Hence Moseley's work has been continued in the Research Laboratories, with the result that more has been learned about matter. How does water freeze? What is lead? Why are lead, iron, gold and tungsten malleable? Such questions can be answered more definitely now than ten years ago. And because they can be answered it is possible to make more rapid progress in illumination, in X-ray photography, in wireless telegraphy, and in electrical engineering as a whole.

There would have been no coal-tar industry without the vast amount of research conducted in organic chemistry, and no electro-chemical industry without such work as Sir Humphrey Davey's purely scientific study of an electric current's effect on caustic potash and caustic soda. Sooner or later research in pure science always enriches the world with discoveries that can be practically applied. For these reasons the Research Laboratories of the General Electric Company devote so much time to the study of purely scientific problems.

General Electric

General Office **Company** Schenectady, N.Y.

15-302-B

"—but the wire has no hole for electricity to flow through"

IT was a lawyer talking, and when he made this brilliant observation an engineer present couldn't help chuckling.

How absurd, he thought, that anybody could be so ignorant of the properties of current electricity.

But by the way, oh stern critic, what are mechanics' liens and what are the mutual obligations of partners? When the talk turns to law or business or the seven arts, have you opinions to express and can you express them without the fear of making a "break"?

Looked at in this light there seems to be some sense to the argument for a broad curriculum for engineers.

Though your object should be first and foremost to find out more than anybody else knows about some specialized phase of engineering, don't miss any chance to get acquainted with every common interest which may influence the social and industrial life of the day.

This is nothing but a matter of good business. It will enable you to meet men on their own ground.

And because life is too full to learn everything about everything, this habit teaches the greatest lesson of all—the necessity of getting at fundamentals and applying basic princples already learned to each new problem.

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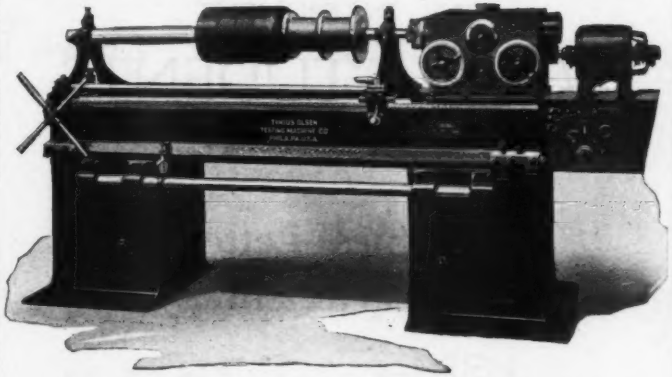

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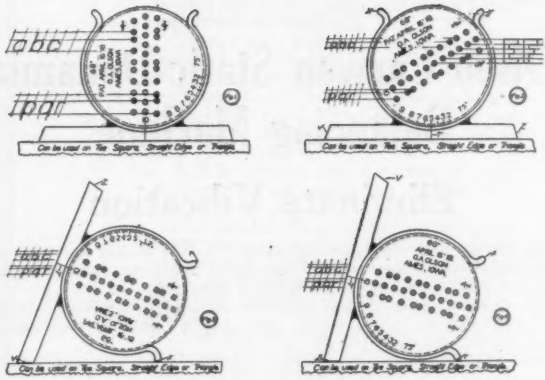

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